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PASSIVE SMOKING AND MIDDLE EAR PROBLEMS IN KANSAS PUBLIC SCHOOL CHILDREN

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Survey data from parents of Kansas school children identified as having middle ear problems were compared to data obtained from parents of children who passed their school's hearing screening tests. The results of the investigation revealed that there were no differences between the two groups of children for the presence of smoking, the amount and type of smoking, and the number of smokers in the home. Exposure to cigarette smoke in the home apparently was not a risk factor for middle ear problems in children.

INTRODUCTION

Research over the past half-century indicated that smoking causes cancer of the lung, larynx, oral cavity, and esophagus, and is significantly associated with pancreas, urinary bladder, and kidney cancer in both men and women (U.S. Department of Health and Human Services (DHHS), 1981). Further, a clear dose–response relationship has been established between smoking and a number of disease states.

Public awareness of the dangers of smoking has steadily increased over the years, including the danger of "passive" or involuntary smoking (DHHS, 1981). Several investigators have reported the negative effect of parental smoking on children's health (Bergman and Wiesner, 1976; Cameron et al., 1969; Cameron and Robertson, 1973; Colley, 1974; Colley et al., 1974; Comstock et al., 1971; Harlap and Davies, 1974; Kraemer et al., 1983; Saxton, 1978; Tager et al., 1979). One of the most frequently mentioned group of illnesses in children that has been associated with parental smoking was respiratory illnesses.

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The relationship of smoking and hearing abilities also has been investigated. Zelman (1973) found that smokers manifested greater hearing losses than nonsmokers, especially at the higher frequencies. Smokers also have been shown to have less temporary threshold shifts than nonsmokers (Dengerink et al., 1984). Cantrell (1970) reported that tobacco smoking caused eustachian tube malfunction and adversely affected the tympanic membrane. Marston, Sterrett, and McLennan (1980), however, found no significant effect on the admittance characteristics at the plane of the tympanic membrane in young adult smokers.

With regard to passive smoking and hearing ability in children, Saxton (1978) reported that infants whose mothers smoked during pregnancy manifested reduced or impaired auditory function as compared to infants whose mothers did not smoke. In addition, Kraemer and colleagues (1983) found that exposure to two or more household cigarette smokers increased children's risk for persistent middle ear effusions (PMEE) nearly threefold, fourfold with exposure to smoke from more than three packs per day. Children with the combined factors of atopy, nasal congestion, and exposure to cigarette smoke were six times more likely to manifest PMEE.

Examination of the literature indicated a paucity of data regarding the effects of passive smoking on the incidence of middle ear problems in children. In a reanalysis of some of the Kraemer et al. data, Rogers and colleagues (1984) suggested that there was not enough evidence to establish cigarette smoke exposure as a risk factor for PMEE. Further data, therefore, need to be obtained to determine the effects of passive cigarette smoking in children and middle ear problems. Also, because the Kraemer et al. data were obtained in Seattle, a city that has reduced air quality, similar information from a relatively "clean" air environment, such as Kansas (National Commission of Air Quality, 1981), should provide useful, additional data.

The purpose of the present investigation was to obtain survey data from parents of Kansas school children identified as having middle ear problems and compare them to data obtained from parents of children who passed their school's hearing screening tests. Information was obtained regarding the number of household smokers, the amount and type of household smoking, and the number of middle ear problems.

PROCEDURES

A questionnaire (see Appendix A) was developed to obtain the pertinent data from parents of Kansas school children. The questionnaire was attached to a cover letter for the parent (or guardian) of each child, which provided general information about the investigation and the rights of the participants.

The questionnaires were copied on different colored paper for easy identification. White forms were given to parents of children who had

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been identified by a physician as having a middle ear problem. These children had failed the school's hearing screening procedures and were referred to a physician for diagnosis. Blue forms were given to parents of children who had passed the school's hearing screening test.

The exact hearing screening procedures might have varied slightly between school districts. The minimum procedures established by state regulations are bilateral pure tone screening at 25 dB HL for the frequencies .5, 1, 2, 4, and 6 kHz (Kansas Department of Education (DOE)/Department of Health and Environment (DHE), 1980). Each child who passed the screening test responded appropriately to the test stimuli. Each child who failed the screening test was rescreened at a later date. If the child failed the rescreening, a pure-tone threshold was obtained. A child was referred for a complete audiometric evaluation and an examination by a physician if the hearing test results showed a loss of 30 dB at two frequencies or 35 dB at one frequency in either ear (KDOE/DHE, 1980). Personnel in some school districts with the appropriate equipment obtained tympanograms as well. The experimental (i.e., diagnosed by a physician with middle ear problems) and control (i.e., passed school's hearing screening) groups, therefore, did not undergo identical subject selection procedures. The subject selection procedures, however, followed the procedures for the identification of middle ear problems in Kansas public schools. The authors determined that these procedures were appropriate for the present survey investigation.

A total of 1600 questionnaires, 800 white forms and 800 blue forms, were divided between the special education directors of each school district in Kansas by the Kansas Department of Education. Ten questionnaires of each color were given to smaller districts; 25 questionnaires of each color were given to larger districts. The directors had been informed, in advance, of the investigation.

Written instructions were provided with the questionnaires to each director. The instructions included:

1. the meaning of the color code;
2. the number of questionnaires provided;
3. the procedures used to code subjects, sex, school district, and age;
4. the procedures to match children from the experimental (i.e., diagnosed with middle ear problems) and control (i.e., passed school's hearing screening test) groups; and,
5. the deadline date and address to return the questionnaires.

Subjects were matched by age, within ± 6 months, and sex. For the statistical analyses, the subjects were grouped by age according to the following categories: less than or equal to 6;6, 6;6 to 8;0, and greater than 8;0 (years;months). Each matched-subjects pair fell within the same age category; no matched pairs crossed age categories. All subjects were se-

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lected, according to the hearing screening and medical exam results, by the staff of the local school district.

RESULTS

A total of 344 questionnaires (21.5%) were returned to the investigators. Of those returned, a total of 238 questionnaires (119 matched pairs) were used in the analyses. One hundred and six questionnaires were excluded from study for a variety of reasons, most often because they lacked an appropriately matched sample. Table 1 shows a breakdown of the 238 subjects by age and sex.

The results of the investigation revealed a significant difference between the two groups for the number of middle ear problems during the last year ($\chi^2 = 96.6$; $df = 3$; $p < .0001$). The members of the experimental group, each of whom was identified by a physician as manifesting a middle ear problem, had significantly more episodes of middle ear problems than the members of the control group, each of whom passed the school's hearing screening test. This finding was important because it was conceivable that some children with a middle ear problem might pass a pure-tone screening, thereby confounding the control group.

There were nonsignificant differences between the two groups on items regarding the presence of smoking in the home ($\chi^2 = 2.84$; $df = 1$; $p > .05$), the number of smokers in the home ($\chi^2 = 2.88$; $df = 2$; $p > .05$), the type of smoking in the home ($\chi^2 = 3.52$; $df = 2$; $p > .05$), and the amount of cigarette ($\chi^2 = 6.55$; $df = 4$; $p > .05$), cigar ($\chi^2 = 0$; $df = 1$; $p > .05$), and pipe ($\chi^2 = 3.23$; $df = 1$; $p > .05$) smoking in the home.

Figure 1 shows the number of homes in each group with the presence and absence of smoking. Cigarette smoking was by far the greatest type of smoking in the home. One hundred and seven respondents indicated that cigarette smoking occurred in the home as compared to 12 respondents who indicated that some other type of smoking occurred.

Figure 2 shows the number of household smokers for each group. Kraemer and colleagues (1983) reported a greater risk for PMEE in children with exposure to two or more household smokers or smoke from more

Table 1. A Breakdown by Age and Sex of the 238 Subjects

Sex	Age group < 6:6	6:6–8:0	> 8:0	Total
M	38	36	60	134
F	30	48	26	104
Total:	68	84	86	238

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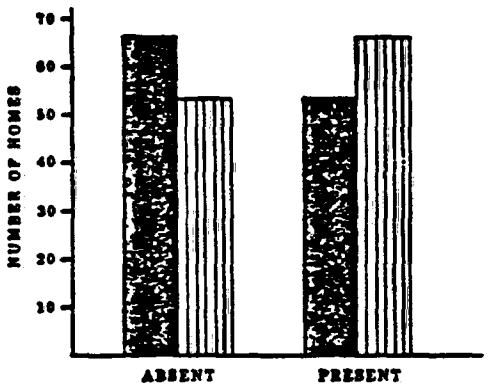
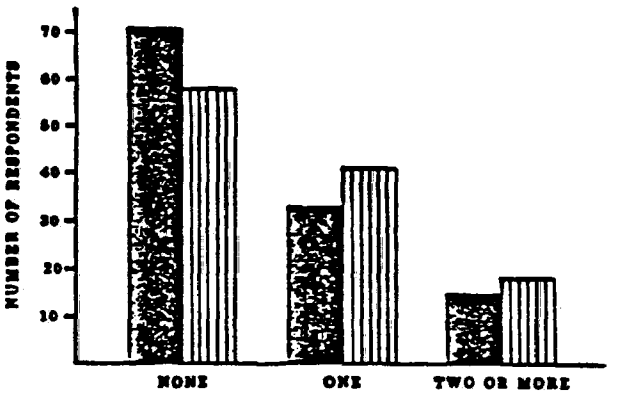


Figure 1. The number of homes with smoking absent and present in the control (solid black) and experimental (black lines) groups.

than three packs of cigarettes per day. A nonsignificant trend is shown in Figure 2 in which the experimental group exhibited more homes with more smokers than the control group. For example, 19 respondents in the experimental group and 15 respondents in the control group reported two or more smokers in the home.

Figure 2. The number of respondents in the control (solid black) and experimental (black lines) groups by the number of household smokers.



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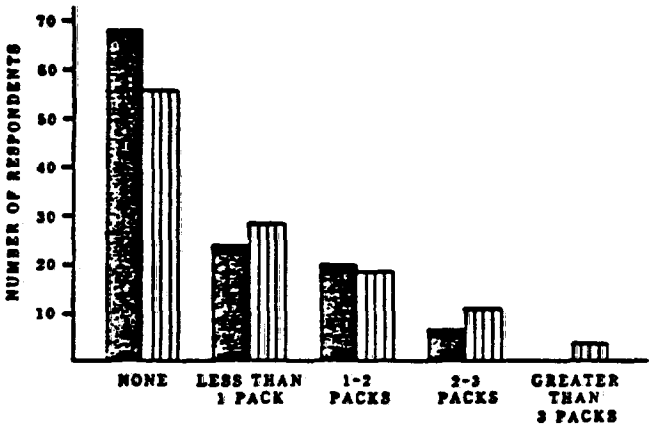

Figure 3. The number of respondents in the control (solid black) and experimental (black lines) groups by the amount of cigarette smoking in the home.

Figure 3 shows the number of respondents in each group by the amount of cigarette smoking in the home. A nonsignificant trend is shown in Figure 3 in which the experimental group reported more smoke in the home than the control group. For example, four respondents in the experimental group and none in the control group reported smoke from more than three cigarette packs per day in the home.

These nonsignificant trends also appeared for cigar and pipe smoking. A greater amount of cigar and pipe smoking was reported for the experimental group. Two respondents in the experimental group and one in the control group reported that cigars were smoked in the home for more than three hours per day. Three respondents in the experimental group and none in the control group reported that pipes were smoked in the home for more than one hour per day.

The results also showed no significant differences in the episodes of middle ear problems by age ($\chi^2 = 8.51$; $df = 6$; $p > .05$) or by sex ($\chi^2 = .41$; $df = 3$; $p > .05$). Apparently, the matching procedures used in this investigation were adequate.

DISCUSSION

Survey investigations traditionally have low response rates. Unfortunately, low response rates may render the results of a survey questionable. The need for follow-up to nonrespondents has been emphasized earlier

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(Ferber et al., 1980). In the present investigation, the low response rate seemed to result from the failure of the school personnel to distribute and collect the surveys by the established deadline rather than a reluctance of parents to respond. The most common reasons for failing to return the completed questionnaires were that the school personnel forgot to distribute them and that they were too busy with end-of-year responsibilities.

Certainly, if some parents (e.g., smokers) were more likely not to respond than others (e.g., nonsmokers), the survey results would be invalid. The fact that there were nonsignificant differences for the number of smokers in the matched pairs for each group seemed to validate the results. Apparently, smokers and nonsmokers were equally likely to complete the survey.

The results of the present investigation revealed no differences between the experimental and control groups for the presence of smoking, the amount and type of smoking, and the number of smokers in the home. It also was interesting to note a nonsignificant trend for children exposed to very heavy smoking in the home often to have middle ear problems. For these children, a larger sample might have revealed significant differences. Further study of this important health factor is encouraged.

The present study supported the conclusions of Rogers et al. (1984) that exposure to cigarette smoke in the home was not a risk factor for middle ear problems in children. Rogers et al. (1984) reanalyzed previous data from Kraemer et al. (1983) by controlling for the influence of nasal congestion. They suggested that it was the nasal congestion that influenced Kraemer's significant results, not exposure to household cigarette smoking.

Another factor to be considered in the relationship between passive smoking and middle ear problems in children is the effects of air quality. A large body of evidence has indicated a qualitative relationship between air pollution and disease (Perera and Ahmed, 1979). As mentioned earlier, the Seattle, Washington area (where Kraemer's data were collected) has reduced air quality. The state of Kansas has a relatively "clean" air environment. Cigarette smoking and air pollution have been recognized by epidemiological experts as independent factors, which when combined produce an additive and in some cases a synergistic effect (Perera and Ahmed, 1979). The relative elimination of air pollution in the present investigation suggested that tobacco smoke exposure alone might not be as great a risk factor for middle ear problems in children as previously assumed.

It should be pointed out once again that the health risks of smoking, both active and passive, were evident in the literature. The relationship between passive smoking and middle ear problems in children, however, is apparently a complex one. The risks of middle ear problems from exposure to tobacco smoke most probably increase when in combination

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with other risk factors, such as air pollution or nasal congestion, or when the smoke exposure is excessively heavy.

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APPENDIX A: QUESTIONNAIRE

I.D. # ___ ___ ___ ___ Age ___
District/Cooperative # _____
Please respond to the following items completely and accurately.

1. For the school-age child identified above, what is the number of episodes of middle ear problems during the last year?
   ___ None ___ 1 to 2 ___ 3 to 6 ___ more than 6
2. What was the most recent method of treatment for the middle ear problem?
   ___ None ___ Medication
   ___ antihistamine
   ___ antibiotic
   ___ antihistamine and antibiotic
   ___ other (specify) _____
   ___ Surgery
   ___ PE tubes (tubes placed in eardrum)
   ___ mastoidectomy
   ___ other (specify) _____
3. How has the number of episodes of middle ear problems changed over the last three years?
   ___ No change ___ Increased ___ Decreased
4. Does smoking of any kind occur in your place of residence?
   ___ Yes ___ No
   If "yes", please complete the remainder of the form.
5. Check each type of smoking that occurs in the place of residence on a typical day (consider both residents and visitors).
   ___ Cigarette ___ Cigar ___ Pipe
6. Check the number of smokers living in your place of residence.
   ___ 1 ___ 2 ___ 3 or more
7. Check the total amount of cigarette smoking by all smokers that occurs within your place of residence on a typical day.
   ___ None ___ Less than one pack
   ___ At least one pack but less than two
   ___ At least two packs but less than three
   ___ Three packs or more
8. Check the total amount of pipe smoking by all smokers that occurs within your place of residence on a typical day (double count if two people smoke a pipe at the same time).
   ___ None ___ Less than one hour
   ___ At least one hour but less than three hours
   ___ At least three hours but less than five hours
   ___ Five hours or more
9. Check the total amount of cigar smoking by all smokers that occurs within your place of residence on a typical day (double count if two people smoke cigars at the same time).

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___ None ___ Less than one hour
___ At least one hour but less than three hours
___ At least three hours but less than five hours
___ Five hours or more

10. Please add any comments that you feel may be helpful to our investigation. If necessary use the back of this page.

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